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United States Patent [19]

Ross

[11] **Patent Number:** 6,163,780[45] **Date of Patent:** Dec. 19, 2000[54] **SYSTEM AND APPARATUS FOR
CONDENSING EXECUTABLE COMPUTER
SOFTWARE CODE**[75] **Inventor:** Richard A. Ross, Berkeley, Calif.[73] **Assignee:** Hewlett-Packard Company, Palo Alto,
Calif.[21] **Appl. No.:** 09/053,260[22] **Filed:** Apr. 1, 1998**Related U.S. Application Data**

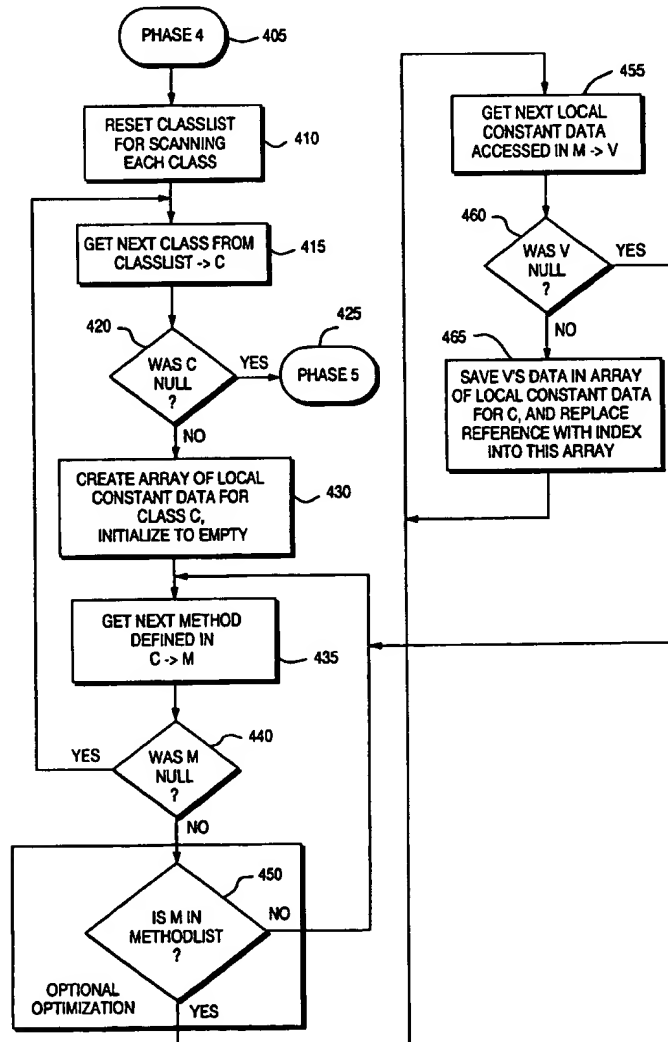
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[51] **Int. Cl.⁷** G06F 17/30[52] **U.S. Cl.** 707/101[58] **Field of Search** 707/101-103;
395/701, 705, 707, 709; 341/51, 78; 717/6,
8[56] **References Cited****U.S. PATENT DOCUMENTS**

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Primary Examiner—Hosain T. Alam[57] **ABSTRACT**

A system and method of condensing computer code in which canonical lists are created with index values replacing code structures within the code. More particularly, in JAVA code, condensed code is created by making canonical lists of classes, methods and fields in the code and replacing such class, method and/or field references within the code with index values corresponding to the canonical lists.

21 Claims, 12 Drawing Sheets

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TITLE: System and apparatus for condensing executable computer software code

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INVENTOR-INFORMATION:

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US-CL-CURRENT: 707/101

CLAIMS:

What is claimed is:

1. A method of condensing executable computer code in a computer system, the computer code including a plurality of types of code structures, each of the types of code structures including a plurality of identifiers, and the computer system including a memory for storing the computer code therein, the method comprising the steps of:
reading the executable computer code from the said memory;
creating a first list of the plurality of identifiers for a first of the types of code structures;
creating a first indexed list of the identifiers for the first type of code structure, the first indexed list including a plurality of index references, each of the identifiers in the first indexed list corresponding to at least one of the index references in the first indexed list; and
creating a condensed executable computer code, including the steps of scanning the executable computer code and replacing each occurrence in the executable computer code of the identifiers listed in the first indexed list with the respective index reference in the first indexed list corresponding to the respective identifier.
2. The method of claim 1, wherein the step of creating the first list of the plurality of identifiers includes scanning the executable computer code and introducing said identifiers into said list.
3. The method of claim 1, comprising the steps of:
creating a second list of the plurality of identifiers for a second of the types of code structures;
creating a second indexed list of the identifiers for the second type of code

structure, the second indexed list including a plurality of index references, each of the identifiers in the second indexed list corresponding to at least one of the index references in the second indexed list; and creating a condensed executable computer code, including the steps of scanning the executable computer code and replacing each occurrence in the executable computer code of the identifiers listed in the second indexed list with the respective index reference in the second indexed list corresponding to the respective identifier.

4. The method of claim 3, comprising the steps of: creating a third list of the plurality of identifiers for a third of the types of code structures; creating a third indexed list of said identifiers for the third type of code structure, the third indexed list including a plurality of index references, each of the identifiers in the third indexed list corresponding to at least one of the index references within the third indexed list; and creating a condensed executable computer code, including the steps of scanning the executable computer code and replacing each occurrence in the executable computer code of the identifiers listed in the third indexed list with the respective index reference in the third indexed list corresponding to the respective identifier.

5. The method of claim 1, wherein: the code structures within the executable computer code include classes and the identifiers for the class code structures include class names, the step of creating a first list of the plurality of identifiers includes creating a list of the class names, the step of creating a first indexed list of the identifiers includes creating a first indexed list of the identifiers includes creating a first indexed list of classes and associating each of the classes with a unique index reference, and the step of replacing each occurrence in the executable computer code of the identifiers in the first list with the respective index reference includes replacing each class in the executable computer code with its respective index reference in the first indexed list.

6. The method of claim 1, wherein: the code structures within the executable computer code include methods and the identifiers for the method code structures include method names, the step of creating a first list of the plurality of identifiers

includes creating
a list of the method names,
the step of creating a first indexed list of the identifiers includes
creating a
first indexed list of methods and associating each of the methods with
a unique
index reference, and
the step of replacing each occurrence in the executable computer code
of the
identifiers in the first list with the respective index reference
includes replacing
each method in the executable computer code with its respective index
reference in
the first indexed list.

7. The method of claim 1, wherein:

the code structures within the executable computer code include fields
and the
identifiers for the field code structures include field names,
the step of creating a first list of the plurality of identifiers
includes creating
a list of the field names,
the step of creating a first indexed list of the identifiers includes
creating a
first indexed list of fields and associating each of the fields with a
unique index
reference, and
the step of replacing each occurrence in the executable computer code
of the
identifiers in the first list with the respective index reference
includes replacing
each field in the executable computer code with its respective index
reference in
the first indexed list.

8. The method of claim 3, wherein:

the code structures within the executable computer code include methods
and fields,
the identifiers for the method code structures including method names
and the
identifiers for the field code structures including field names,
the step of creating a first list of the plurality of identifiers for
the first of
the types of code structures includes creating a list of the method
names,
the step of creating a first indexed list of the identifiers for the
first type of
code structure includes creating a first indexed list of methods and
associating
each of the methods with a unique index reference,
the step of replacing each occurrence in the executable computer code
of the
identifiers in the first list with the respective index reference
includes replacing
each method in the executable computer code with its respective index
reference in
the first indexed list,
the step of creating a second list of the plurality of identifiers for
the second of

the types of code structures includes creating a list of the field names,
the step of creating a second indexed list of said identifiers for the second type
of code structure includes creating a second indexed list of fields and associating
each of the fields with a unique index reference, and
the step of replacing each occurrence in the executable computer code of the
identifiers in the second list with the respective index reference
includes
replacing each field in the executable computer code with its
respective index
reference in the second indexed list.

9. The method of claim 3, wherein:

the code structures within the executable computer code include classes and fields,

the identifiers for the class code structures including class names and the

identifiers for the field code structures including field names,

the step of creating a first list of the plurality of identifiers for the first of

the types of code structures includes creating a list of the class names,

the step of creating a first indexed list of the identifiers for the first type of

code structure includes creating a first indexed list of classes and associating

each of the classes with a unique index reference,

the step of replacing each occurrence in the executable computer code of the

identifiers in the first list with the respective index reference

includes replacing

each class in the executable computer code with its respective index reference in

the first indexed list,

the step of creating a second list of the plurality of identifiers for the second of

the types of code structures includes creating a list of the field names,

the step of creating a second indexed list of said identifiers for the second type

of code structure includes creating a second indexed list of fields and associating

each of the fields with a unique index reference, and

the step of replacing each occurrence in the executable computer code of the

identifiers in the second list with the respective index reference
includes

replacing each field in the executable computer code with its
respective index

reference in the second indexed list.

10. The method of claim 3, wherein:

the code structures within the executable computer code include classes and methods,

the identifiers for the class code structures including class names and the

identifiers for the method code structures including method names,
 the step of creating a first list of the plurality of identifiers for
 the first of
 the types of code structures includes creating a list of the class
 names,
 the step of creating a first indexed list of the identifiers for the
 first type of
code structure includes creating a first indexed list of classes and
 associating
 each of the classes with a unique index reference,
 the step of replacing each occurrence in the executable computer code
 of the
 identifiers in the first list with the respective index reference
 includes replacing
 each class in the executable computer code with its respective index
 reference in
 the first indexed list,
 the step of creating a second list of the plurality of identifiers for
 the second of
 the types of code structures includes creating a list of the method
 names,
 the step of creating a second indexed list of said identifiers for the
 second type
 of code structure includes creating a second indexed list of methods
 and associating
 each of the methods with a unique index reference, and
 the step of replacing each occurrence in the executable computer code
 of the
 identifiers in the second list with the respective index reference
 includes
 replacing each method in the executable computer code with its
 respective index
 reference in the second indexed list.
 11. A method of condensing executable computer code in a computer
 system, the
 executable computer code including class, method and field types of
code structures,
 each type of code structure including a plurality of identifiers, and
 the computer
 system including a memory for storing the executable computer code
 therein, the
 method comprising the steps of:
 reading the executable computer code from the memory;
 creating lists of the plurality of identifiers for each of the class,
 method and
 field code structures within the executable computer code;
 creating indexed lists of said identifiers for each of the class,
 method and field
code structures, each of the respective indexed lists including a
 plurality of index
 references, each of the identifiers in each of the lists corresponding
 to at least
 one of the index references in the respective indexed list; and
 creating a condensed executable computer code, including the steps of
 scanning the
 executable computer code and replacing each occurrence within the
 executable

computer code of the identifiers listed in each of the indexed lists with the respective index reference corresponding to the respective identifier.

12. A data storage medium including machine readable code thereon for use in a computer system having a memory for storing executable computer code, the executable computer code including a plurality of types of code structures, each of the types of code structures including a plurality of identifiers, the storage medium comprising:

- means for creating a first list of the plurality of identifiers for a first of the types of code structures;
- means for creating a first indexed list of the identifiers for the first type of code structure, the first indexed list including a plurality of index references, each of the identifiers in the first indexed list corresponding to at least one of the index references in the first indexed list; and
- means for creating a condensed executable computer code, including means for scanning the executable computer code and replacing each occurrence in the executable computer code of the identifiers listed in the first indexed list with the respective index reference in the first indexed list corresponding to the respective identifier.

13. The data storage medium of claim 12 comprising:

- means for creating a second list of the plurality of identifiers for a second of the types of code structures;
- means for creating a second indexed list of the identifiers for the second type of code structure within the computer code, the second indexed list including a plurality of index references, each of the identifiers in the second indexed list corresponding to at least one of the index references within the second indexed list; and
- means for creating a condensed executable computer code, including means for scanning the executable computer code and replacing each occurrence in the executable computer code of the identifiers listed in the second indexed list with the respective index reference in the second indexed list corresponding to the respective identifier.

14. The data storage medium of claim 12, wherein: the code structures within the executable computer code include classes, and the identifiers for the class code structures include class names,

the means for creating a first list of the plurality of identifiers creates a list of the class names, the means for creating a first indexed list of the identifiers creates a first indexed list of classes and associates each of the classes with a unique index reference; and the means for replacing each occurrence in the executable computer code of the identifiers in the first list with the respective index reference replaces each class in the executable computer code with its respective index reference in the first indexed list.

15. The data storage medium of claim 12, wherein: the code structures within the executable computer code include methods, and the identifiers for the method code structures include method names, the means for creating a first list of the plurality of identifiers creates a list of the method names, the means for creating a first indexed list of the identifiers creates a first indexed list of methods and associates each of the methods with a unique index reference; and the means for replacing each occurrence in the executable computer code of the identifiers in the first list with the respective index reference replaces each method in the executable computer code with its respective index reference in the first indexed list.

16. The data storage medium of claim 12, wherein: the code structures within the computer code include fields, and the identifiers for the field code structures include field names, the means for creating a first list of the plurality of identifiers creates a list of the field names, the means for creating a first indexed list of the identifiers creates a first indexed list of fields and associates each of the fields with a unique index reference; and the means for replacing each occurrence in the executable computer code of the identifiers in the first list with the respective index reference replaces each field in the executable computer code with its respective index reference in the first indexed list.

17. The data storage medium of claim 13, wherein: the code structures in the executable computer code include methods and fields, the identifiers for the method code structures including method names and

the
 identifiers for the field code structures including field names,
 the means for creating a first list of the plurality of identifiers for
 the first of
 the types of code structures creates a list of the method names,
 the means for creating a first indexed list of the identifiers for the
 first type of
code structure creates a first indexed list of methods and associates
 each of the
 methods with a unique index reference,
 the means for replacing each occurrence in the executable computer code
 of the
 identifiers in the first list with the respective index reference
 replaces each
 method in the executable computer code with its respective index
 reference in the
 first indexed list,
 the means for creating a second list of the plurality of identifiers
 for the second
 of the types of code structures creates a list of the field names,
 the means for creating a second indexed list of said identifiers for
 the second type
 of code structure creates a second indexed list of fields and
 associates each of the
 fields with a unique index reference, and
 the means for replacing each occurrence in the executable computer code
 of the
 identifiers in the second list with the respective index reference
 replaces each
 field in the executable computer code with its respective index
 reference in the
 second indexed list.

18. The data storage medium of claim 13, wherein:
 the code structures in the executable computer code include classes and
 fields, the
 identifiers for the class code structures including class names and the
 identifiers
 for the field code structures including field names,
 the means for creating a first list of the plurality of identifiers for
 the first of
 the types of code structures creates a list of the class names,
 the means for creating a first indexed list of the identifiers for the
 first type of
code structure creates a first indexed list of classes and associates
 each of the
 classes with a unique index reference,
 the means for replacing each occurrence in the executable computer code
 of the
 identifiers in the first list with the respective index reference
 replaces each
 class in the executable computer code with its respective index
 reference in the
 first indexed list,
 the means for creating a second list of the plurality of identifiers
 for the second
 of the types of code structures creates a list of the field names,
 the means for creating a second indexed list of said identifiers for

the second type
of code structure creates a second indexed list of fields and
associates each of the
fields with a unique index reference, and
the means for replacing each occurrence in the executable computer code
of the
identifiers in the second list with the respective index reference
replaces each
field in the executable computer code with its respective index
reference in the
second indexed list.

19. The data storage medium of claim 13, wherein:
the code structures in the executable computer code include classes and
methods, the
identifiers for the class code structures including class names and the
identifiers
for the method code structures including method names,
the means for creating a first list of the plurality of identifiers for
the first of
the types of code structures creates a list of the class names,
the means for creating a first indexed list of the identifiers for the
first type of
code structure creates a first indexed list of classes and associates
each of the
classes with a unique index reference,
the means for replacing each occurrence in the executable computer code
of the
identifiers in the first list with the respective index reference
replaces each
class in the executable computer code with its respective index
reference in the
first indexed list,
the means for creating a second list of the plurality of identifiers
for the second
of the types of code structures creates a list of the method names,
the means for creating a second indexed list of said identifiers for
the second type
of code structure creates a second indexed list of methods and
associates each of
the methods with a unique index reference, and
the means for replacing each occurrence in the executable computer code
of the
identifiers in the second list with the respective index reference
replaces each
method in the executable computer code with its respective index
reference in the
second indexed list.

20. A data processing system having means for reading executable
computer code, the
executable computer code including a plurality of code structures, each
code
structure including an identifier, the data processing system
comprising:
means for creating a list of the identifiers;
means for creating an indexed list of the identifiers, the indexed list
including a
plurality of index references, each of the identifiers in the indexed

list
corresponding to at least one of the index references in the indexed
list; and
means for creating a condensed executable computer code, including
means for
scanning the executable computer code and replacing each occurrence in
the
executable computer code of the identifiers listed in the indexed list
with the
respective index reference in the indexed list corresponding to the
respective
identifier.
21. A method of condensing executable computer code in a computer
system, the
computer code including a plurality of types of code structures, each
of the types
of code structures including a plurality of identifiers, the method
comprising the
steps of:
creating a list of identifiers for each type of code structure;
creating an index reference corresponding to each of the identifiers in
each of the
lists; and
replacing each of the identifiers in the executable computer code with
the
respective index reference corresponding to each respective identifier.